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FRIAR ROGER BACON

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ROGER BACON, one of the greatest men of genius who have done honour to the history of Western thought and the greatest of English medieval philosophers, was born at or near Ilchester, Somerset, in 1214, in the last years of King John, one year before Magna Charta.

Bacon suffered cruel persecution from the ignorance and superstition of his own age, and misrepresentation and neglect from the six centuries that followed his own work; and it is only in our own generation that his transcendent merits have been understood and even that his writings have been made accessible and accurately published. Few thinkers and discoverers in the whole history of thought have lain under so prolonged a period of misinterpretation and oblivion. As it is, much of his writing is not even printed. The editor of his principal work in 1733 even deepened the error by burking the most important part of the whole. Few students of modern philosophy read his works more than cursorily and in sections. And even serious students did not read them at all. His fame, such as it was, rested on an absurd legend; and a man whose life was given to experimental science and systematic canons of organic philosophy was treated as if he were a charlatan and a magician. The only magic in Bacon's life is the melancholy truth that one whose mind is by centuries in advance of his time has to suffer a martyrdom in his person and a long epoch of oblivion to his merits.

The few known facts of Bacon's life can be shortly told. It is not quite certain that he was born in the year 1214, nor that the place was in Ilchester—but this date and birth place

are the more probable. He says himself that his brother was a rich man, and that he had expended a considerable sum of his own on instruments, books, and materials for study. It is thought that the young Roger was the same clerk who gave a clever suggestion to King Henry III., in his contest with the barons. Certainly the Bacon family stood by the King in the war and was ruined and exiled. He tells us that he had been an ardent student of philosophy and science, ever since the year 1227, when he must have been only thirteen or fourteen. All through the long civil wars of Henry's reign, Roger pursued his studies at Oxford and at Paris, conversing with learned men to be found in the schools of both. Having exhausted his own fortune of "two thousand pounds," and finding his family unable to help him, Bacon entered the Order of St. Francis, and about his thirteenth year became Friar Roger, and took the degree of Doctor of Theology. But his bold original mind, and still more his criticism of the worldliness and ambition of the monastic Orders, made him suspected of "new ideas" and heresies, and when he was about the age of forty-three, in 1257, he was removed to Paris from Oxford and placed under close supervision or imprisonment.

He continued to study and to work, but was forbidden to make public any writings, and had great difficulty in procuring parchment to record his observations and thoughts. This close time lasted for some ten years; but in 1266 his friends seem to have induced the Pope, Clement IV., to command Bacon to send to him an exposition of his system. In the astonishing space of one year the *Opus Majus* was completed and sent to Rome in 1267. This was just after the Parliament of 1265, which first embodied a real representative of the Commons. Thus Bacon's principal work is almost contemporary with our Parliamentary system. A few months afterward, the Pope Clement died: his successor was appointed for three years; and the next Popes were alien to Bacon's ideas. In 1278, when Bacon was about sixty-four, he was condemned for heresy and imprisoned, though he still continued to write smaller treatises. In 1292 or 1294, at the age of seventy-eight or eighty, he died at Oxford and was buried in the Franciscan Church there, whilst his memory remained there for some three or four centuries as a professor of the magical art and as the inventor of some more or less uncanny discoveries and instruments.

To sum up the essential points on which the greatness of Roger Bacon must depend—they are:

- I. He was the first of the exponents of natural science in modern Europe—the earliest prophet of the experimental method.
- II. His was the most encyclopaedic mind of the Medieval world—having the most systematic range of general philosophy. I am inclined to hold him in this to be the widest thinker since the Greeks, until we reach the time of Descartes, Francis Bacon, and Leibnitz.
- III. He was far the most original intellect in natural science between Hipparchus (B. C. 150) and Galileo (1564).
- IV. He was a real Martyr of Science—being a man of heroic courage, perseverance, moral and religious earnestness.

Experimental Science—The Sixth Part of the *Opus Majus* is devoted to what Bacon names *Scientia Experimentalis*, and it opens with the striking aphorism: *sine experientia nihil sufficienter scire potest*. He says there are two ways of acquiring knowledge: 1. by reasoning; 2. by experiment. No reasoning can make the mind entirely rest in belief, until the truth of it has been shown by actual experiment. This was laid down nearly four hundred years before the *Novum Organum* of Francis Bacon.

This Experimental Science, he says, has three *prerogatives*, that is, typical characters, namely:

- a. Experiment confirms conclusions to which deduction or abstract reasoning has pointed but has not verified.
- b. It reveals new truths which take their place in other sciences, but were previously unobserved.
- c. It creates new departments of science.

(a) As an illustration of experimental method, Bacon then elaborately discusses the principle of the Iris (nebular rainbow). The theory of the rainbow is sufficiently explained by geometry. But this theory can be verified by observing the iridescence in natural objects—in crystals, drops from the oar, from a water-wheel, in the morning dew. In these, the same colours, in the same order, can be seen. He then explains how, by observing the sun's altitude, the degree of latitude, and the position of the spectator, the phenomena of

the rainbow as stated by a mathematician can be ocularly demonstrated to an observer. "In latitude lower than $24^{\circ} 25'$ no rainbow is possible at noon even in winter." Bacon devotes eleven chapters to experimental observation of iridescence in various conditions. He did this with astonishing insight.

(b) In the second character of experimental science, i. e., its opening out new truths, Bacon discusses the possibility of an astrolabe moved automatically by the motion of the earth—the astrolabe was an ancient instrument in use up to the times some five hundred years after Bacon. Again, he passes to some bold suggestions as to the means of prolonging human life, mainly by observing practical rules of hygiene, but, I fear, we must add that he gives a prescription for a wonderful drug compounded of gold, pearl, spermaciti, aloes and other materials. In another chapter he deals with the refinement of gold.

(c) In the third phase of experimental science Bacon goes into utopian dreams of astrology, of explosives, poisons, the magnet, and the divining rod. In the *Opus Majus* he merely notes these possible new discoveries. We know that he worked on several and studied magnetic attraction, but the result of his inventions is no longer recoverable.

The sixth part of the *Opus Majus* covers so wide a ground that it would need practically a treatise to explain it. But, by simply noting the heads of various chapters, we can learn how truly Roger Bacon is the father of experimental science in Europe.

The fifth part of one hundred and sixty-six pages is devoted to the science of Optics—beginning with the physiology of the organs of sight, and then the mathematical theory of vision. Herein we find some astonishing anticipations of modern and much later knowledge. "Vision," says Bacon, "is in the brain—only as its instrument, in the eye." He deals with short and long sight, the true understanding of which was not reached until five hundred years after Bacon. Again, he says, "the propagation of light is not really *instantaneous*, though enormously more rapid than that of sound." Yet Francis Bacon adhered to the old theory that light was transmitted without time. Of course, Roger Bacon had not instruments such as enabled Roemer in 1675 to prove that the light even of the distant stars occupied time, but he saw the truth in his mind's eye four hundred years earlier.

Another of Roger's anticipations of modern science was his aphorism that "no bodies are so dense that no rays can pass through them." He laughs at the old sophism that "a lynx can see through a wall"; but he imagined the permeability of solids six hundred years before the discovery of X-rays.

Another of his anticipations was his doctrine of the ponderability of air. He discusses the weight of the atmosphere, whilst his contemporaries and his successors believed air to be without weight, just as they believed light to be transmitted without time—though we now know light to be transmitted in about two hundred thousand miles per second.

There are really few subjects of natural science on which Roger's mind was not occupied in observation and experiment as well as in criticizing the theories of Aristotle and the Greeks, and the Arabian scientists: the laws of refraction, of incidence and reflection, of the convergence of rays, of temperature, of climate, of the tides, of the moon's phases, of the spherical nature of the earth, of the uniformity of matter, which he repudiates as atheistic materialism, of the weight of falling bodies, in which he revived the old sophism which Galileo refuted some three hundred years after Bacon. He discusses the habitable portion of the globe, and the proportion of land in relation to the sea (he says, not one-third). The sources of the Nile, he believes, are in a vast central lake, and the annual rise of the Nile is due to Spring rains. Then he passes to the dimensions of the earth, as compared with the sun and moon.

Now it is, of course, impossible in a multitude of such difficult problems, with rude instruments, surrounded by the gross superstitions and conventions of the dark ages, that Roger the Friar, in his prison-like cell, could have attained to definite truth and knowledge. But he constantly touches the truth in a tentative way. He understood the microscope, and he just worked around the parts of the telescope without at all reaching the true combination which produced the instrument three hundred years later. He discusses the properties of petroleum and of Greek fire and explosives. He clearly knew the ingredients of gunpowder, but he had no idea of using its explosive force in a tube. He had some adumbration of the possibility of a flying machine.

But as Roger was a more systematic philosopher than Francis, he reduced his scheme of experimental science to

various definite axioms. He says: "Nothing can be held certain until it has been verified by experiment."

This was written in the age of the Crusaders, and the Barons' war against Henry III. There are some crucial points on which we may claim Roger Bacon's vast superiority to his age:

1. His criticism of the Julian Calendar, and his own law of the annual circuit of the earth: a calendar which was not settled in England until five hundred years after him.
2. His criticism of the inaccuracies in the Vulgate translation of the Bible, and the necessity of new translations from the Greek and the Hebrew—both of which languages he knew himself.
3. His criticism of the incorrect knowledge of Aristotle and of the ancients, and of the need to recover their works largely by means of the Arabian and Jewish men of science.
4. His foundation of experiment as the true basis of real science.
5. His insight into such problems as the form of our earth, the ponderability of air, the penetrability of solids to rays, the velocity of light, the possibilities of spectrum analyses.
6. His invariable habit of connecting knowledge of Nature with the improvement of human life.
7. His belief in the continuity of science, and the filiation of all human discoveries—joining the classics with the moderns, the East with the West, primitive civilization with contemporary times.
8. The desire to make science the instrument of morality and religion, and to harmonize the discoveries of ancients and scholastics with the teaching and discipline of the Church.

II. I turn now to the second point to which I call attention—the encyclopaedic character of Bacon's intellect, the vast range of his studies. This was the special faculty of the students of the thirteenth century—their rare privilege. It was then possible for a man of incredible industry and profound capacity, shut up in a monastery where there was almost nothing but books, and nothing to do but to read and to think,—it was possible for such a one to master almost all

that was to be found in books, and to range over the whole field of contemporary science. Men like Albert the Great of Cologne, Thomas Aquinas, Dante, and one or two schoolmen, could do this. But the Friar Roger is the most conspicuous example of this universal knowledge of the sciences. Aristotle is the great Greek example, and in a vague and very amateur way, Pliny the Elder was at Rome. But I incline to rank Roger as the widest of all the Medieval scholars.

We have only to look at the various divisions of his work:

1. First Principles—the Causes of Error—a. authority, b. custom, c. popular prejudice, d. conceit of our own wisdom.
2. The affinity of philosophy and theology. Such schoolmen as Peter Abelard regarded theology as field for sophisms. Churchmen like Bonaventura, who condemned Roger, cared little for philosophy. But Roger's whole mind was set on the conciliation of philosophy and theology, which in the thirteenth century did not seem utopian.
3. Philology, proof of the need for knowledge of Greek and Hebrew to study the Scriptures, and also of Arabic to read the Oriental men of science. Perhaps not three men in England at Bacon's death could read Greek, much less Hebrew or Arabic.
4. Mathematics, including Astronomy, Optics, Astrology, Chronology, the Calendar, and the Geography of the earth.
5. Optics, Physical and Mental; Reflection and Refraction of rays of light.
6. Experimental Science, on which I have enlarged in previous pages.
7. Moral Philosophy—Man and God. Morality, the comparative Study of Religions—the superiority to all of the Christian faith. Again, in what Bacon calls his *Scriptum Principale*, to which the *Opus Majus* was introductory, the Sections are:
 1. Logic and Comparative Grammar in Various Languages.
 2. Mathematics, Geometry, Arithmetic, Astronomy and Music.
 3. Natural Science, including Barology, Alchemy, Agriculture, Physiology, Medicine.
 4. Metaphysics and Morals.

Without pretending that Roger was complete master of all these branches of knowledge, or that his knowledge was entirely accurate, we see that it was sympathetic, logical, and intelligent, even when he was wrong, or short of accurate data. Where he is in error, none of his contemporaries knew any better; and he often was right when they were in error or in utter ignorance.

Roger's great maxim was:

"All the sciences are connected; they lend each other material aid as parts of one great whole," each doing its own work, not for itself alone, but for the other parts, as the eye guides the whole body, and the foot sustains and leads it from place to place. No single department of wisdom can attend to its proper result separately, "since all are parts of one and the same complex wisdom."

What a reflection in this profound maxim on the narrow specialization of our age, and the hide-bound sections to which science is jealously restricted! Friar Roger was one of the earliest to realize the continuity of all solid human thought, as he was the first to preach the co-operation, or what may be called the Solidarity, of all the Sciences.

As to the originality of Roger, almost everything said above tends to support it. But in the general view of the problem, it will be seen that, after the discoveries of the later Greek geometers, practically no original work in science was accomplished in Europe, for we have no reason to think that either the Plinys or even Galen made any original step in science. For at least ten centuries Europe was absorbed in war, in re-settlement of nations, in law, morals, and religion—not in science. Philosophy and science passed over into Asia, which inherited and kept alive the Greek traditions and writings. Europe from the time, say, of Constantine, to that of Copernicus and Galileo, was too busy with fighting, or with theology, law and art, to trouble itself about philosophy and science, which it left to a few monastic students. Of these, the most versatile, and the most original and penetrating spirit was the Oxford Friar, Roger Bacon.

Lastly, I claim Roger as a martyr of sciences. He was by so many centuries in advance of his age that his scientific knowledge was treated as magic; his experiments were devices of the black art; for four centuries his name was associated mainly with a mechanical toy which could speak. Samuel Johnson's famous line in the *Vanity of Human*

Wishes—" And Bacon's mansion trembles o'er his head " —recalls the popular saying that Bacon's cell or work-room in the Tower of the South or Watergate of Oxford would fall when a greater than Roger passed under it. Even in the seventeenth century he was mainly remembered for his astrology. And it was not till the eighteenth century that his chief work was even printed. For some fifteen years of his life he was practically a prisoner. But what was worse than prison to him, he was forbidden by his Superior to publish or even communicate to others his ideas. Being now a mendicant friar without money, and having exhausted his own fortune in scientific research, he was unable even to buy parchment to put down his thoughts. He was formally condemned by his Church and Order, and regarded as a dangerous heretic. His great work, the *Scriptum Principale*, was never completed—at least, it does not exist now. His writings in scattered and disconnected manuscripts were rarely seen even by students and theologians. Francis, in the plenitude of his earthly glory, refers to him as an obscure monk. Until five hundred years after his own time the *Opus Majus* was never printed, and then was mutilated and issued with manifold errors. Even now the scattered and disordered manuscripts of the indefatigable Friar are only published in detached works—French, English, or German. And some are still manuscript in unvisited shelves. Thus, the earliest founder of Science in Modern Europe is still unknown to men of science. And one of the noblest divines in the central and characteristic age of the Catholic Church is still a heretic and an outcast.

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